

Technical Standard Order

PROPOSED

Subject: ROTORCRAFT, TRANSPORT AIRPLANE, AND NORMAL AND UTILITY AIRPLANE SEATING SYSTEMS

1. **PURPOSE.** This Technical Standard Order (TSO) prescribes the minimum performance standards (MPS) that rotorcraft, transport airplane, and normal and utility airplane seating systems of the following designated types must meet in order to be identified with the applicable TSO marking:

Type A - Transport Airplane

Type B - Rotorcraft

Type C I - Normal & Utility Airplane - Crew Seats

Type C2 - Normal & Utility Airplane - Passenger Seats

2. **APPLICABILITY.** Previous versions of this TSO are not effective for applications submitted after the effective date of this TSO. Seating systems approved under a previous TSO authorization may continue to be manufactured under the provisions of their original approval. Major design changes to seating systems approved under a previous version of this TSO requires a new authorization under this TSO, per 14 CFR 21.61 1 (b) .

3. **REQUIREMENTS.** New models of seating systems that are to be so identified and that are manufactured on or after the effective date of this TSO must meet the MPS, qualification

requirements, and minimum documentation requirements set forth in Society of Automotive Engineers, Inc. (SAE), Aerospace Standard (AS), Document No. AS 8049, "Performance Standards for Seats in Civil Rotorcraft and Transport Airplanes," dated July 1990, as amended by APPENDIX I of this TSO.

a. Additional information on the dynamic testing of seating systems is contained in Advisory Circular (AC) 20-137, "Dynamic Evaluation of Seat Restraint Systems & Occupant Restraint for Rotorcraft (Normal & Transport)," AC 23.562-1, "Dynamic Testing of Part 23 Airplane Restraint/Systems and Occupant Protection," and AC 25.562-IA, "Dynamic Evaluation of Seat Restraint Systems & Occupant on Transport Airplanes".

b. Environmental Qualification There are no environmental test procedures referenced in this TSO or SAE AS 8049.

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c. Deviations The FAA has allowed provisions for using alternative or equivalent means of compliance to the criteria set forth in the MPS of this TSO. Applicants invoking these provisions shall demonstrate that an equivalent level of safety is maintained and shall apply for a deviation in accordance with 14 CFR 21.609.

4. MARKING. In accordance with 14 CFR 21.607 (d), articles manufactured under this TSO must be marked as follows:

a. At least one major component must be permanently and legibly marked with all of the information listed in 14 CFR Part 21.607(d), except for the option provided for in 14 CFR 21.607(d)(3), where the date of manufacture must be used in lieu of the optional serial number, and

(1) The applicable seat type: "Type A-," "Type B-," "Type C I -," or "Type C2-" followed by the appropriate seat facing direction designation: "FF"-forward; "RF"-rearward; and "SF"-sideward.

(2) The seating system, safety belt, and seat cushion part numbers.

(3) For Type A passenger seating systems, the minimum seat pitch necessary to maintain sufficient clearance to assure an effective emergency evacuation, as defined in

(4) Optional marking is permitted to allow aircraft-specific installation limitations, such as follows: "**FOR USE ON**(insert aircraft type or serial number**ONLY.**" or "**FOR USE ON AIRCRAFT USED IN PART 91 OPERATIONS ONLY**"

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b. In addition to the requirements of 14 CFR 21.607(d), each separate component that is easily removable (without hand tools), an interchangeable element, or a separate subassembly of the article must be permanently and legibly marked with at least the name of the manufacturer, manufacturer's part number, and the TSO number, and

c. In addition to the requirements of 14 CFR 21.607(d), for Type A and Type B transport passenger, flight attendant, and observer seating systems, each seat cushion must be marked with "Complies with 14 CFR [25.853(c) or 29.853(b), as applicable] effective 1 1/26/84," when tested in accordance with the requirements of Section 3.4.2 of SAE AS 8049, as revised by subparagraph 2.2.3 of APPENDIX I of this TSO.

5. DATA REQUIREMENTS

a. Application Data. In accordance with 14 CFR 21.605(a)(2), the manufacturer must furnish the Manager, Aircraft Certification Office (ACO), Federal Aviation Administration (FAA), having purview of the manufacturer's facilities, one copy each of the following technical data to support the FAA design and production approval:

(1) Operating instructions and equipment limitations. The limitations shall be sufficient to describe the operational capability of the equipment.

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(2) Installation procedures and limitations. The limitations shall be sufficient to ensure that the article, when installed in accordance with the installation procedures, continues to meet the requirements of this TSO. The limitations shall also be sufficient to identify any unique aspects of the installation. Installation instructions and limitations shall include all pertinent restrictions or other conditions relevant to the seating system installation in an aircraft. In particular, a description shall be provided to cover any installation limitations identified in

Subsection 5.3.10.3 Test Results: b, h, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, and z of SAE AS 8049, as revised by subparagraph 2.2.8 of APPENDIX I of this TSO and specifically any head strike path or permanent structural deformations, as reported in subparagraph 5a(11) below, that may have an impact on emergency evacuation. The limitations also shall include the following.

(i) A note with the following statement:

"The conditions and tests required for TSO approval of this article are minimum performance standards. It is the responsibility of those desiring to install this article either on or within a specific type or class of aircraft to determine that the aircraft installation conditions are within the TSO standards. The article may be installed only if further evaluation by the applicant documents an acceptable installation and is approved by the Administrator."

- (3) Schematic drawings as applicable to the installation procedures.
- (4) Wiring diagrams as applicable to the installation procedures.
- (5) Material and process specifications.
- (6) List of the components, by part number, that make up the seating system complying with the standards prescribed in this TSO.
- (7) The quality control functional test specification to be used to test each production article to ensure compliance with this TSO, as required by 14 CFR 21.605(a)(3) and 21.143(a).
- (8) Manufacturer's TSO qualification test report.
- (9) Nameplate drawing.
- (10) A drawing list, enumerating all of the drawings and processes that are necessary to define the article's design,

(11) Detailed seat back and seat pan cushion configuration drawings including foam, fire blocking layer, as required, and dress cover specifications and a report of the tests conducted in accordance with the fire protection provisions of Section 3.4.2 of SAE AS 8049, as revised by subparagraph 2.2.3 of APPENDIX I of this TSO, and the static and dynamic qualification test results of Section 5 of SAE AS 8049, with a description of any equivalent procedures provided in subparagraph 2.1.3 of APPENDIX I of this TSO, for qualification and approval of seating systems.

(12) Detailed periodic cleaning, maintenance, and repair instructions for continued airworthiness, including specific guidance on the limits of wear and damage permissible to the seat cushions and safety belt webbing material which would warrant replacement, i.e., explain how and/or when these materials lose their system effectiveness and when the strength of the webbing would be expected to drop below the specified abrasion breaking strength. Include recommended inspection intervals and service life.

b. Manufacturer Data In addition to those data requirements that are to be furnished directly to the FAA, each manufacturer must have available for review by the manager of the ACO having purview of the manufacturer's facilities, the following technical data:

(1) The functional qualification specifications to be used to qualify each production article to ensure compliance with this TSO.

(2) Equipment calibration procedures.

(3) Corrective maintenance procedures within 12 months after TSO authorization.

(4) Schematic drawings.

(5) Wiring diagrams.

c. Furnished Data

(1) One copy of the data and information specified in paragraph ~~5a~~ **(1), (2), (3), (11), and (12)** of this TSO and any other data or information that are necessary for the proper installation certification and use and/or for continued airworthiness of the seating system must go

to each person, i.e. installer and/or operator, receiving for use one or more articles manufactured under this TSO.

6. AVAILABILITY OF REFERENCED DOCUMENTS

a. Copies of SAE AS 8049 and SAE J211 may be purchased from the Society of Automotive Engineers, Inc., Department 331, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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b. Federal Aviation Regulations, 14 CFR Part 21, Subpart 0, 14 CFR Part 23, 14 CFR Part 25, 14 CFR Part 29, and 49 CFR Part 572 may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325.

c. Advisory Circular 20-1 10, "Index of Aviation Technical Standard Orders," AC 20-137, AC 23.562-1 and AC 25.562-1A may be obtained from the U.S. Department of Transportation, Utilization and Storage Section, M-443.2, Washington, DC 20590.

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APPENDIX 1. MINIMUM PERFORMANCE STANDARD FOR ROTORCRAFT⁹

TRANSPORT AIRPLANE, AND NORMAL AND UTILITY AIRPLANE SEATING SYSTEMS

1. P=ose. This appendix prescribes the MPS for seating systems, as modified by the FAA for reference in this TSO.

2. Requirements The standards applicable to this TSO are set forth in the industry standard specified in paragraph 3 of this TSO. SAE AS 8049, "Performance Standards for Seats in Civil Rotorcraft and Transport Airplanes," dated July 1990, which is the applicable standard is modified as follows:

2.1 Exceptions

2.1.1 The information contained in Section ~~SCOPE~~ and Section: 2.REFERENCE PUBLICATIONS of SAE AS 8049 is duplicative and shall be disregarded.

2.1.2 Compliance with Section 3.Guidance of SAE AS 8049 is not required, except for Subsections 3.1.8, 3.1.11, 3.1.14 (passenger seats only), and 3.1.15.

2.1.3 Compliance with the dynamic test procedures and documentation of Subsection 5.3.1 Dynamic Impact Test Parameters: through Subsection 5.3.9.Impact Pulse Shape of SAE AS 8049 may be demonstrated by equivalent procedures. For example, the pulse shape described in either AC 23.562-1 or 25.562-1A would be acceptable in lieu of the pulse shape of Subsection 5.3.9.2 of AS 8049. The simplified procedures for HIC outlined in policy letter TAD-96-002 dated 2/16/96 and contained in Attachment I of this appendix also may be used in lieu of the selection of test conditions described in Subsection 5.3.6.2 of AS 8049. The use of an equivalent pulse shape or test parameter must be established by the applicant and accepted in advance by the Manager, Aircraft Certification Office (ACO), Federal Aviation Administration (FAA), having geographic purview of the applicant's facility.

2.1.4 Compliance with the dynamic impact test pass/fail criteria of Subsections 5.4.3, 5.4.4, and 5.4.9 of SAE AS 8049 for permanent deformation limits, head injury criteria (HIC), and femur loads, respectively, is not required. However, the data must be reported, as required by subparagraph ~~5.a(1)~~ **5.a(1)** of this TSO.

2.1.5 Disregard the marking requirements specified in Section 5.5 of SAE AS 8049. Marking of the article shall be in accordance with paragraph 4 of this TSO.

2.2 Additions

2.2.1 For the specified procedures of subparagraph 2.1.2 and the use of the equivalent procedures outlined in subparagraph 2.1.3 of this appendix, above, a proposed plan for demonstrating compliance and providing the required documentation shall be submitted to the FAA ACO manager, at least 30 days prior to the application for TSO authorization per 14 CFR 21.605(a) of the Federal Aviation Regulations (FAR).

2.2.2 Under Section 3.2Requirements:of SAE 8049, add a new Subsection to read as follows: The vertical angle subtended by the projection of the pelvic restraint centerline and the buttock/seat reference point (BRP/SRP) water line shall not be less than 45 degrees nor greater than 55 degrees. The BRP/SR-P water line is a line/plane passing through the BRP/SRP parallel to the horizon. The pelvic restraint centerline is formed by a line from the pelvic restraint anchorage to a point located 9.75 inches forward of the SRP and 7.00 inches above the BRP/SRP water line. This point represents the location of the top of the pelvic restraint situated on the prominence of the anterior superior iliac spine of the 50th percentile male occupant, as determined for the anthropomorphic test dummy (ATD) specified in Subsection 5.3Occupant Simulation: of SAE AS 8049. Therefore, the pelvic restraint anchorage point must be located so that the pelvic restraint centerline intersects the BRP/SRP water line between 2.5 inches and 4.5 inches forward of the SRP, (see Attachment 2 to this appendix).

2.2.3 Replace Subsection 3.4.2 of SAE AS 8049 with the following: Type A-Transport Airplane and Type B-Transport Rotorcraft passenger, flight attendant, and observer seat cushion systems shall be tested and shall meet the fire protection provisions of Appendix F, Part 11 of 14 CFR Part 25, as required in 14 CFR 25.853(c) and 14 CFR 29.853(b) respectively, or the equivalent shall be demonstrated by analysis (similarity) to provide equivalent protection. Type B- Normal Rotorcraft upholstery shall be self extinguishing when tested to meet the fire protection provisions of 14 CFR 27.853(b). Type C I - and C2Normal & Utility Airplane seat cushions shall be self extinguishing when tested to meet the fire protection provisions of paragraph (c) of Appendix F of 14 CFR Part 23, as required in 14 CFR 23.853(d)(3)(ii).

2.2.4 Strengthening: Revise TABLE I - ULTIMATE LOAD FACTORs of Subsection 4.1Static of SAE AS 8049 to add Type C seat load factors as follows:

Direction (Relative	Type A Seat (Transport Airplane)	Type B Seat (Rotorcraft)	Type C Seat (Normal & Utility Airplanes)
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to Aircraft)	Factor	Factor	Factor
Forward			9.0
Sideward			1.5(2)
Upward			3.0(2)
Downward			6.0(2)
Rearward			

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2.2.5 Revise Subsection 4.1.4 Casting Factors: of SAE AS 8049 to add "23.621" after ... "FAR Section."

2.2.6 Add to Subsection 5.3 Dynamic Qualification Tests of SAE AS 8049 a new FIGURE 7a - Type C Seat/Restraint System Dynamic Tests contained in Attachment 3 to this appendix.

2.2.7 Revise Subsection 5.3 Dynamic Qualification Tests: of SAE AS 8049 to add reference to the new FIGURE 7a - Type C Seat/Restraint System Dynamic Tests. Wherever "Figure 6 and 7" appears, change to read "Figure 6, 7, and 7a."

2.2.8 In Subsection 5.3.1.4 of SAE AS 8049, change the first sentence to read: Test 2 for Type A and Type C seats ...

2.2.9 The following three items shall be included in Subsection 5.3.10 Test Results: of SAE AS 8049: 1. Retention of items of mass; m. Post test retrieval of life preserver; and n. Evaluation of seat egress. See Subsections 3.2.6 and 3.2.7 of SAE AS 8049. These three items will be part of the data submittal required by subparagraph **5a(11)** of this TSO.

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Attachment to
Policy Ur. TAD-96-002

Attachment 1

Seat-to-Seat Installation Tests for Compliance with the MC in Transport Airplanes

The following is a set of criteria for use in evaluating FHC with "default" parameters. These criteria can be used to standardize the approach to seat-to-seat FHC, and should enable seat-to-seat FHC for the majority of seats to be addressed in only two tests. The general guidelines are based on a typical passenger seat, although the philosophy could be applied to any seat for which it was valid to do so.

Head Strike Envelope:

AU dynamic tests and MC evaluations are to be conducted with a 50th percentile male anthropomorphic test dummy as defined in 25.562. The head strike envelope includes the three dimensional space through which the AM's head may traverse when tested in accordance with the dynamic conditions defined in 25.562. This three dimensional space includes the AM's head path which occurs during the vertical test as well as the horizontal-yaw test conditions defined in 25.562 (although the horizontal condition typically produces the critical head path). Since the head of the AM is a three dimensional object, the head strike envelope encompasses the path of all points defined by the surface of the ATD's head. This includes the back of the head. The head strike envelope for the horizontal-yaw test condition (Test 2) includes the path through which the AM's head may traverse when tested with a yaw angle of 0, $-10 < 0 < +10$ degrees.

Structures within the Head Strike Envelope

If the head strike envelope results in head contact with a structure located on or in the vicinity of the seat installation in an aircraft, the MC requirement in 25.562 must be demonstrated by test(s). There are some seat-to-seat installation practices which are common to contemporary aircraft, and general guidelines on certification test procedures can be defined. The following examples describe how the various factors affecting the seat-to-seat FHC result can be addressed in the test(s) protocol.

Seat-to-seat MC, Double Row Horizontal-Yaw Tests.

Head Strike Zones. Due to the dynamic deflection of the forward row seat back during the impact test, it is usually difficult to accurately predict exactly where the aft row seated ATD's head will strike the seat back. The typical seat back has three areas that are considered head strike zones within the ± 10 degree yaw range of impact orientation. These are illustrated in **Figure 1**. Note the recline mechanism is on the left side of the seat back in this illustration. The recline mechanism can affect the stiffness of the seat back on the side it is located (Zone A.) Thus, head impact must be evaluated on both the left and right (Zone B) sides of the seat back. The third area of potential head impact is the center of the seat back (Zone C, which may include areas on the seat back containing a tray table, telephone handsets, or video displays.

Since it is common for the recline adjuster mechanism to be positioned on the left side of some seat backs and the right side of others of the same assembly, the seat-to-seat FHC test for Zones A and B can usually be accomplished in one double row test using two instrumented AM's in the aft row, with the yaw angle set to effect a head strike in Zone A by one AM and Zone B by the other. Alternatively, it may be possible to relocate one adjuster mechanism for test purposes. In addition, properly documented developmental test data that indicate that one condition or the other is more critical, could be used to justify head impact on only one side of the seat.

Seat Pitch. The range of intended seat pitch for a particular model of seat should be defined in the certification test plan. The MC assessment test(s) should include, as a minimum, head impact responses for the three head strike zones described above. As a general rule, head impact in Zones A and B is likely to be more severe as the seat pitch increases. This is because the head will strike the seat back at a lower point and will be more likely to contact the arm rest structure. Thus, the maximum intended seat pitch should be evaluated in the critical yaw orientation (within the ± 10 degree envelope) with head impacts directed at Zones A and B.

Another general rule can be applied to head strike Zone C. The severity of head impact in the middle of the seat back can be affected by the tray table and its latch mechanism. Also, convenience items such as telephone handsets or video displays in the vicinity of the tray table may be contacted by the AM's head. To assess the severity of head impact in Zone C, an impact test should be conducted at the minimum intended seat pitch in a 0° yaw (no yaw) impact orientation.

Thus, the seat pitch range for a particular model of passenger seat can be certified in a minimum of two tests. The maximum pitch is tested in the yaw orientation with head impacts directed at Zones A and B. The minimum pitch is tested in 0° yaw with head impact in Zone C. Note that this is based on a typical passenger seat, that has an essentially homogeneous contact area across the seat back, in zone C. Designs that differ from this might require an additional test(s), if the contact surfaces are not consistent.

Occupant Height. Although the seat-to-seat MC tests do not require evaluating head impact with a range of different size ATD's the strike zone near the center of the seat back (Zone C) may

contain significantly different structures within the close proximity of the head contact area for a 50th percentile ATD. For example, at the minimum seat pitch, a 50th percentile ATD may barely miss a telephone handset installed above the tray table. Under the same impact condition, a taller occupant's head may contact the handset. Likewise, a 50th percentile ATD's head may strike the seat back above the tray table, whereas a shorter occupant's head may strike the top edge of the tray, which may be worse. '

In order to provide a consistent level of head impact protection in Zone C for a range of occupant height, it is necessary to examine an area on the seat back near the initial contact point of the 50th percentile ATD's head on the seat back. As a minimum, a rectangular area on the seat back centered at the 50th ATD's initial head contact point must be evaluated. As shown in Figure 2, the area to be evaluated is a 6 by 12 inch rectangle centered on the initial head contact point of the 50th percentile ATD.

. If the head contact evaluation rectangle in Zone C includes structures which differ significantly from the contact point of the 50th percentile ATD, an additional test may be necessary. Conversely, if there are data available to predict the contact point of the 50th percentile ATD, these may be used to select the critical test condition, as the initial test in lieu of the zero degree test

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discussed above. The relative position of the seats in a double row setup must be adjusted to produce head contact with a 50th percentile ATD on the area of concern. Vertical adjustment of the seats' relative position will ensure that a comparable head impact velocity as that measured from the normal position Zone C test is achieved, although other methods that achieve the same objective are acceptable. As a general rule, additional tests are only required if the head contact evaluation rectangle contains rigid items (such as telephone handsets, video screens, and oxygen mask container units.) Areas which are less rigid than the initial contact point within the evaluation rectangle do not require additional tests.

Airplane Taper Section. MC evaluations in the taper sections of the airplane may be conducted with the seat(s) in the normal position without simulating the floor track yaw angle due to taper. The lateral offset between rows of seats in a taper section may be neglected (e.g. the double row IIIC tests may be conducted with no lateral offset) if the lateral offset of the cabin installation is less than 6.0 inches. Note, structural tests of seats installed in the taper section must be conducted with the additional yaw angle due to taper.

Staggered Seating. Seats that are staggered (resulting in more than 6" offset) due to a change in the number seat-places for example, should be addressed considering the actual installation. This may prove to be the critical evaluation for the airplane installation, if contact with armrests or

other hard structure occurs. Such an installation may supersede the "zone A & B" evaluations discussed earlier. Consideration of such installations should still be possible- within the framework of a twotest program, provided that the basic designs are the same.

Forward Row Seat Setup.It is acceptable to conduct the double row seat-to-seat IRC test(s) with no AM's in the forward row seat. Floor deformation should not be induced on either the forward or aft row seats for evaluation of FUC.

Other Factors:

***Head Floor Strikes.**FUC need not be determined for ATD head strikes with the simulated floor of the aircraft should it occur.

-Occupant to Occupant Strikes. Occupant (AID) to occupant (i.e., opposite facing seats) strikes should be prohibited. The biofidelity of the ATD and appropriate injury criteria related to occupant to occupant strikes is unknown and beyond the scope of the seat dynamic performance standards evaluations.

-Sharp Object Strikes.Head strikes with sharp objects are not evaluated with the MC but they are prohibited per the requirements of FAR 25.785.

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APPENDIX 2. TEST CONDITIONS

SAE AS 8049 incorporates, as a reference, the following test standards for which a more recent version of these standards may be substituted, if approved by the FAA ACO manager having geographical purview over the manufacturer's facilities.

1. SAE J21 I- Instrumentation for Impact Tests.
2. Code of Federal Regulations, Title 49, Part 572, Anthropomorphic Test Dummies,